Time Series

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Time series include mooring (slide 4) and hydrography (slide 3) observations collected by EcoFOCI and products obtained using data from other sources. Other sources include: satellites, sea ice from the National Snow and Ice Data Center, high resolution combined model and assimilated dataset (e.g. NARR).

Biophysical Moorings and hydrography:
Approximately 40 moorings are deployed each year as part of EcoFOCI. Eight sites contain long-term moorings, and the remaining sites were deployed to examine mechanisms. While the moorings provide information on temporal variability, hydrography time series provide information on changes in the spatial patterns. Typically we participate in six or more hydrographic and/or mooring cruises each year. In recent years, the focus of the cruises is the Gulf of Alaska in odd years and the Bering Sea in even years.

Bering Sea: The focus here is on the four long-term biophysical moorings in the Bering Sea (slides 5-9). Slides 5 and 6 present how long moorings have been deployed and instrumentation on the moorings. The northern and southern shelves (division at ~60°N) support different ecosystems (Slide 7). Sea-ice in the March and April set up the ecosystem for the following late spring through autumn (Slide 8). On the southern shelf, sea ice has major impact on the timing of the spring phytoplankton bloom (Slide 9). Summer primary production is important and the moorings provide information of introduction of nutrients into the surface layer in response to wind events.

Finally, these moorings contain a wide range of instruments necessary to monitor the ecosystem. At each mooring site are passive listening devices monitoring marine mammals and active acoustics such as the ADCP and other active acoustics which provide information of zooplankton. As carbon dioxide levels in the atmosphere increase, the oceans absorb larger amounts of this gas creating a chemical reaction that increases carbonate ions (Slide 10). In turn, the increased carbonate ions in the ocean impede calcification in marine organisms. Both M8 and M2 have pCO_2 packages on the moorings.

US Arctic: Since 2010, we have had extensive program in the Chukchi Sea with support from BOEM. More recently, support from RUSALCA has permitted observations on the Russian part of the Chukchi Sea. In addition, we provide data to the Distributed Biological Observatory (DBO) in five of the 8 DBO regions (Slide 11).

BOEM has supported three field programs – CHAOZ (field years - 2010-2012), CHAOZ-X (2013-2014) and ArcWEST (2013-2014) (Slide 12). During the last several years there has been at least two cruise to the US Chukchi. Sampling in Chukchi

continued in 2015 with NOAA Ship *Ronald Brown* conducting its first cruise in the Arctic.

Since 2010 we have occupied 6 hydrographic transects and deployed biophysical moorings at 9 different sites (measuring - temperature, salinity, currents, chlorophyll fluorescence, nitrate, PAR, O_2, ice keel depth) (Slide 12). Three of these sites have been occupied almost continuously since 2010, and have been proposed as long-term observation sites. In addition, our research partners National Marine Mammal Laboratory has deployed more than 20 passive acoustic listening devices each year.

The integration of satellite-tracked drifters (~40 deployed with drogue depth of 30 m), hydrography and moorings the flow pattern on the Chukchi Sea has been refined (Slide 13). Using the currents measured on the moorings at Icy Cape since 2010, total transport was calculated. Flow is northeastward, with maximum transport in July. Approximately 40% of the transport through Bering Strait passes Icy Cape.

Satellites, sea ice, high resolution combined model and assimilated dataset

The products obtained from national databases are critical to understanding the ecosystem (Slide 14). The integration of data collected at mooring sites, ice data and NARR wind and sea surface temperature data combine together to form hypothesis that the Bering Sea was warm in 2015 not because of southerly anomalies of wind, but because of strong flow of warm (blob) water out of the Gulf of Alaska into the Bering Sea (Slide 15).

Data Management

Once data are collected, they are processed and entered onto local databases. Meta data such as log sheets and cruise reports are available on local web pages. In addition, data from satellite-tracked drifters are served from PMEL web site. Hydrography and mooring data are sent to a variety of national databases (Slide 16). Out reach is a required component of our research. Presentations to the public and interviews with news organizations occur each year (Slide 17). We provide a number of indices to the Alaska Marine Ecosystem Considerations including sea-ice index for the Bering Sea, an index of eddies in the Gulf of Alaska, the North Pacific climate summary. Together with management we are in the process of evaluating a coccolithophore index possibly for including next year. Multiple web pages are maintained providing basic information such as the Bering Climate and Arctic theme page (Slide 18).

We are a major contributor to refereed journals and regularly make presentations at national and international meetings. The data we collect are important to publications

beyond our own. For instance, data from these moorings play a critical role in quantifying the Bering Sea. For instance, 21 of the 24 papers in the Bering Sea special issue reference the results obtained from the data at M2.